

birth to young larvæ which prospered under the care of the virgin society. All these larvæ, at their final transformation, furnished males, in opposition to the larvæ which had been previously produced by the original mother, and which had furnished only females.

It may, perhaps, be asked whether a strange fecundated mother may not have penetrated accidentally into the nests deprived of their mother, and oviposited here and there in the cells. To this question Von Siebold gives a decided negative. During the four years which he has devoted to the study of these wasps, he has constantly ascertained that the inhabitants of one nest never tolerate the intrusion of a *Polistes* from another colony into their society. The instinct of these Hymenoptera informs them that these intruders are only robbers penetrating into their nest to steal the larvæ and devour them. It is therefore evident that in *Polistes gallicæ* the male individuals originate parthenogenetically from unfecundated eggs.—*Zeitschr. für wiss. Zoologie*, Bd. xx. p. 236; *Bibl. Univ.* March 15, 1870, *Bull. Sci.* p. 271.

On Force and Will. By B. A. GOULD.

Scientists are now of accord that "force can neither be created nor destroyed," and that "the quantity of force in nature is just as eternal and unalterable as the quantity of matter." Its various forms are eminently convertible, yet utterly indestructible. And to avoid that fruitful source of disagreement among the ablest men, which has arisen from the ambiguous signification of the word, we must adopt the meaning which is finding general acceptance, and define force as "that which is expended in producing or resisting motion"—thus clearly discriminating between force and its cause.

In his retiring address before the American Association last year, our honoured ex-president Dr. Barnard presented an argument, so vigorous and clear that I see no room for an adequate rejoinder, in opposition to the doctrine which would extend the principle of the conservation of force to the phenomena of consciousness—"a philosophy which at the present day is boldly taught in public schools of science, and which numbers among its disciples many very able men." He says, for instance:—

"Organic changes are physical effects, and may be received without hesitation as the representative equivalents of physical forces expended. But sensation, will, emotion, passion, thought are in no conceivable sense physical" (*Proc. Amer. Assoc. Chicago*, p. 89).

"The philosophy which makes thought a form of force, makes thought a mode of motion, converts the thinking being into a mechanical automaton, whose sensations, emotions, intellections are mere vibrations produced in its material substance by the play of physical forces, and whose conscious existence must for ever cease when the exhausted organism shall at length fail to respond to these external impulses" (*ibid.* p. 91).

"Thought cannot be physical force, because it admits of no measure. * * A thing unsusceptible of measure cannot be a quan-

tity; and a thing that is not even a quantity cannot be a force" (ibid. pp. 93, 94).

Before the cogent reasoning carried out by President Barnard, of which the general tenor is indicated by these quotations, the view that force affords a middle term between the moral and the material worlds can be sustained as little as the pure materialism against which the argument was directed. But if we ascend a grade higher, and consider that which guides and compels force, as force guides matter, I am disposed to believe that the problem may be nearer to a solution. Yet I offer my views with hesitation, not unmindful of the great thinkers who have considered these exalted topics, and shrinking from the rebuke of presumption.

There is an elegant experiment, in which the tension of a spring is made to produce heat by percussion, thus developing the current from a thermo-electric battery, which by successive modifications of its force exhibits heat, chemical action, magnetic attraction, and finally bends another spring—the same original force successively appearing in all these various manifestations until it is reestablished in its primitive form. In such an experiment the imperfections of the apparatus would of course entail some loss at each successive step, and thus preclude the practical recovery of an available force equal to that expended in the original flexure of the spring. Yet the fact is beyond question that such loss is due solely to the inadequacy of our implements for collecting and transmitting the force at each stage of the experiment: for the law of conservation teaches that it is in every instance converted into other form or forms without diminution. Could such an apparatus be constructed with theoretical perfection, it would represent an eternal circuit of force; and, like the frictionless pendulum in a vacuum, it would exhibit a perpetual motion, after the needful impulse had once been applied. The spring would oscillate for ever, did no extraneous force oppose, whether the force producing its rebound were or were not transmitted through a chain of modifications.

In this inert apparatus no force whatever would have been im-bodied; yet qualities would have been implanted by design, which would compel an indestructible force applied to it to play the part of an unwilling Proteus. The inference seems unavoidable that force may be guided and controlled, compelled to exert itself in this or that shape, without the outlay of any other force for the purpose. If it be objected that it is an intrinsic law of force that it shall change its form in exerting itself, the case is in no wise altered by the expression of this truism. Our design has prescribed, and (extraneous force being absent) might indefinitely prescribe, the modes and directions in which that constant force should manifest itself.

Muscular force is directed, and in its vital action is usually controlled, by will. If we assume it to be coequal with the expenditure of tissue*, measurable alike by its transferred results and by the

* Even if it be also, to some extent, supplied by the disorganization of food not fully converted, the argument is not thereby affected.

decomposition of this tissue, where and what is that power which lets loose or withholds this force, and whose action is attended by a conscious effort? It is the will—a something which directs and controls force without expending it. Not only are thought and forms of consciousness not forces, if the reasoning already adduced be correct, but, although often moral incentives to the will, they are not even motive energies in the sense in which I think we must concede the will to be such. It is true that the exercise of thought is followed by fatigue, yet it is not attended by a sense of effort, except in so far as it is directed by an exertion of the will. And although the former doubtless consumes tissue, have we any reason for believing that the exercise of will does the same, apart from that consumption which corresponds to the forces whose mode of action it prescribes?

Thus it would appear that the metamorphosis of force, though not “work done” in the mechanical sense, is the result of some definite mode of causation. What this causation is, and whether it is susceptible of measurement, are the next questions. In the same category with this agency, or energy, or influence, the vital principle would seem to belong—directing forces while it neither expends nor consumes them. In the growth of organic beings, unstable combinations are formed; and organized structures are thence reared, in which, as Kant has so beautifully said, “all parts are mutually ends and means.” If in such organic development force is consumed, disorganization without decomposition ought to evolve it. Of the deposit of force in the unstable material of the tissues I am not speaking, but of the vitality itself, which represents an energy requisite for the development and growth of organisms, their dissolution being in turn attended by development of inferior forms of life, which suggest that this energy may have again been made available—an energy, too, which is not “force” as this term has just now been defined.

No comparison can be drawn between vitality and those molecular forces which build the crystal. Crystalline forms arise when the molecular attractions enjoy the freest scope; and their construction must be attended by an evolution of force which ought to be recognizable by physical tests, and which should also be measurable by an excess of their resistance to solution, over that of comparatively amorphous masses of the same material, in which equal weights present equal surfaces.

So, too, not only in that individuality which life confers and in the impossibility of insulating or transferring vitality, but also in its hereditary character and its apparent susceptibility of indefinite increase or diminution, the vital energy violates our fundamental conceptions of force, and demands a separate category, seeming to belong in the same with will. If will and life be forms of force, their total amount must be limited by the law of conservation. If, on the other hand, they are outside the realm of forces, we may more readily indulge the conviction to which experience would lead, that their freedom is unfettered by any restrictions within our

knowledge, each enjoying an indefinite, though possibly a correlated scope in its own domain. The indestructibility of both matter and force implies a fixed coefficient of force for matter in equilibrium; but how great is the contrast offered in this respect by such energies as life and will!

Now, if this reasoning be correct, we may have in this class of energies that middle term, so earnestly desired and so intensely needful, which unites the phenomena of matter with those of spirit, and forms the connecting link between science and religion, their harmonious conjunction affording the highest system of philosophy. It is this class of energies which, controlling the forces of matter, guides and governs their modifications and transformations. It is this, moreover, which, inseparable from mind, is exerted by all conscious organism. The mystic play of coequal, but, to our senses, so dissimilar forces, and the equally recondite mutual action of the eye, the brain, and the nerve, alike demand agencies transcending all our science, yet implicitly obeying physical laws. The highest manifestation of these agencies is in will; the highest agent is the Almighty. Thus the dictum of faith, that the universe exists only by virtue of the continued will of its Creator, represents a palpable scientific fact; and we may see that the pantheist, the materialist, and the spiritualist (I will not be debarred from this noble word by the associations of its misuse to-day) have been contemplating the same exalted truth from different aspects, with limited ranges of vision.—*Silliman's American Journal*, March 1870.

On the Constitution and Mode of Formation of the Ovum of the Sacculinæ. By M. BALBIANI.

In a note inserted in the 'Comptes Rendus' of the 29th November last, M. E. van Beneden undertook to show that the interpretation given by M. Gerbe to the facts observed by him in his investigation of the mode of formation of the ovum of the *Sacculina* is incorrect. At the same time he presents a very different explanation of these facts, and he concludes by rejecting as unfounded the inductions which M. Gerbe had drawn from his observations with regard to the constitution of the ovum in a great number of animals. In his memoir M. E. van Beneden also criticizes the opinions that I have put forward as to the nature and physiological function of the peculiar body first seen in the ova of certain spiders by some German observers, and which I subsequently made the subject of a special memoir, presented to the Academy in 1864. I shall endeavour to reply hereafter to those of M. E. van Beneden's assertions which concern me; but in the meantime it is not without interest to inquire which, M. Gerbe or M. van Beneden, is in the right in the explanation proposed by him of the facts observed by him in the *Sacculina*.

Let us first recall in a few words the manner in which these facts were detailed by M. Gerbe. According to this observer the ovum of